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Table IV, page 16, AF Missile Development Center Technical Report 61-33, " A Laboratory Model for a Fourteen Day Orbital Flight with a Chimpanzee", dated October 1961, should be changed as follows:

Measure	Observations	Range	Mean	S.D.	S.E.m	S.E.m(.05)	S.E.m(.01)
Sk[illegible] Temp (G[illegible]in)°F	699	93.2-98.5	95.4	1.01	.04	.08	.10
Ski[illegible] Temp (C[illegible])°F	580	85.5-93.2	89.2	1.74	.07	.14	.18

AIR FORCE MISSILE DEVELOPMENT CENTER
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Holloman Air Force Base, New Mexico

 AFMDC-TR-61-33

AIR FORCE MISSILE DEVELOPMENT CENTER

TECHNICAL REPORT

A LABORATORY MODEL FOR A FOURTEEN DAY ORBITAL FLIGHT WITH A CHIMPANZEE

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NEW MEXICO

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Project 6893

Task 689301

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ABSTRACT

A young male chimpanzee was restrained on a plastic couch and isolated from the usual laboratory distractions for 14 days. Assuming a 90 minute orbit, the subject performed a complex psychomotor task for approximately nine hours each day and received all of his food and water as rewards for his performance. Skin temperature, pulse, and respiration were monitored throughout the test and urine and feces were collected outside the isolation cubicle and measured. The subject lost no weight for the test period and recovery was rapid.

PUBLICATION REVIEW

This Technical Report has been reviewed and is approved.

FOR THE COMMANDER

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A LABORATORY MODEL FOR A FOURTEEN-DAY ORBITAL FLIGHT WITH A CHIMPANZEE

I. INTRODUCTION

In order to interpret the physiological and psychological changes which may arise in a living organism during space flight, a standard or norm must be established to serve as a basis for comparing these changes. In turn, the standard that is established will only be as reliable as the extent to which the environments of the flight itself are simulated. When considering the many environmental factors associated with prolonged orbital flight, one of the most critical is the extended period of restraint. Certainly this is paramount when considering a flight with an animal subject.

The success enjoyed by the MA-2 Project Mercury flight suggests that the chimpanzee is an excellent precursor to humans in any manned space flight program. However, until this study, the longest time that a chimpanzee had been restrained was 28 hours. Obviously, a longer period of restraint would be required for this species to be considered for a flight of long duration.

Thus, the purpose of this study was to develop a laboratory model for a 14-day orbital flight with a chimpanzee. The findings would serve as standards for the physiological and performance measurements for an actual flight and would provide

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empirical data on food and water consumption and the amount of waste products under the controlled laboratory conditions of isolation and restraint.

II. METHODS

A. Subject

The subject was a male chimpanzee whose age, based upon dental eruptions, was estimated to be 63 months. Prior to this investigation he had received approximately 1093 hours of training on the performance tasks; 173 hours of this training was accomplished under conditions of restraint comparable to those used in this study, however, most of the restraint periods were of one hour duration. In addition, prior to this study the animal had been a subject in acceleration studies conducted on the centrifuge at the University of Southern California, Los Angeles.

B. Apparatus

The apparatus consisted of three main pieces of equipment: an isolation cubicle, a restraint couch, and a performance test panel. A cut-away drawing of the cubicle showing the couch and test panel is presented in Figure 1. The cubicle is basically a portable testing booth designed to isolate the subject from the distractions originating within the laboratory. The outside wall of the cubicle is covered with acoustical tile and the inside wall is lined with galvanized metal. A "dead-air" space of 2 inches between these walls, together with the acoustical tile, affords a moderate degree of attenuation of sound originating outside the cubicle. The cubicle is 54 inches long, 36 inches

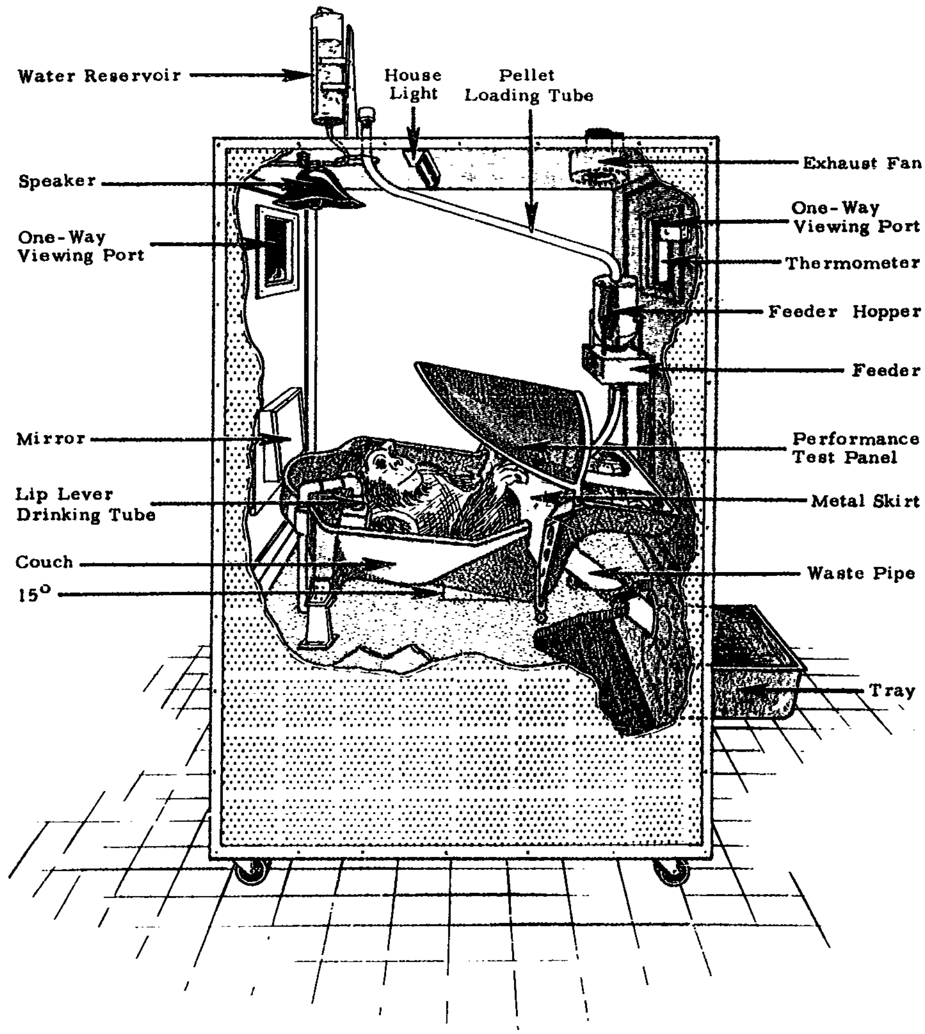

Figure 1. Cut-Away Drawing of the Isolation Cubicle Showing the Couch and Performance Test Panel

wide, and 77 inches high, however, due to a storage compartment at the bottom of the cubicle, the dimensions of the area in which the subject was housed were 47 inches long, 30 inches wide, and 57 inches high (interior measurements).

Each end of the cubicle has a door that contains a 5-inch by 11-inch viewing port of one-way glass. One door contains a series of baffles to permit the entrance of laboratory air without allowing light to enter the cubicle. The air is exhausted from the cubicle by a fan which is mounted on top of the cubicle. A mirror was mounted on one of the doors to permit visual monitoring of the test panel without opening the cubicle door. To permit measurement of the temperature inside the cubicle, a thermometer was mounted in such a manner that it could be read through one of the viewing ports in the door. A 15-watt standard cool white flourescent lamp provided the illumination inside the cubicle. This was kept on throughout the test and since the laboratory was illuminated only by a small desk lamp, the greater illumination within the cubicle afforded visual monitoring of the cubicle interior without distracting the subject. A loud speaker was mounted on the ceiling of the cubicle directly above the subject's head.

The electrical connections between the test panel and programming equipment and from the physiological sensors to the recorder were made through a hole in the floor of the cubicle. A reservoir for water was mounted on top of the cubicle, and food pellets were loaded into the feeder hopper by means of a one-inch diameter tube that protruded through the roof of the cubicle.

The restraint system consisted of a plastic couch molded to fit the body contours of the subject and a nylon-mesh suit that was worn by the subject. The subject was restrained in the couch by means of straps which were sewn to the suit and fitted through slots in the couch. The subject's legs were held in the couch by nylon lacings at the lower leg. Soft leather shoes, equipped with brass innersoles for delivering electrical shock, were worn by the subject. The couch was mounted in the cubicle so that the angle formed by the vertical axis of the subject's torso and the floor of the cubicle was approximately 15 degrees. This meant that the subject's anus was at the lowest point on the couch, approximately 5 inches below his head. A 3-inch hole was drilled in the couch at this point and an aluminum pipe was attached to the couch which extended to the outside of the cubicle to permit the collection of feces and urine. To facilitate the cleaning of the pipe a 0.125-inch copper tube was mounted one inch below the point where the pipe was attached to the couch. The tube was directed away from the couch toward the outside and water was forced through the tube by means of a standard garden hose that was connected to the tube at the exterior cubicle wall. This arrangement permitted the collection of waste products outside the cubicle and prohibited clogging of the pipe with fecal material. Excreta were collected in a pan which was fitted with a screen to permit separation of the solid and liquid waste.

The performance test panel was attached to the couch and mounted in front of the subject as shown in Figure 1. A metal skirt was attached to the bottom of the panel to prevent the subject from reaching the electrical connections on the back of the panel. A photograph of the panel is presented in Figure 2.

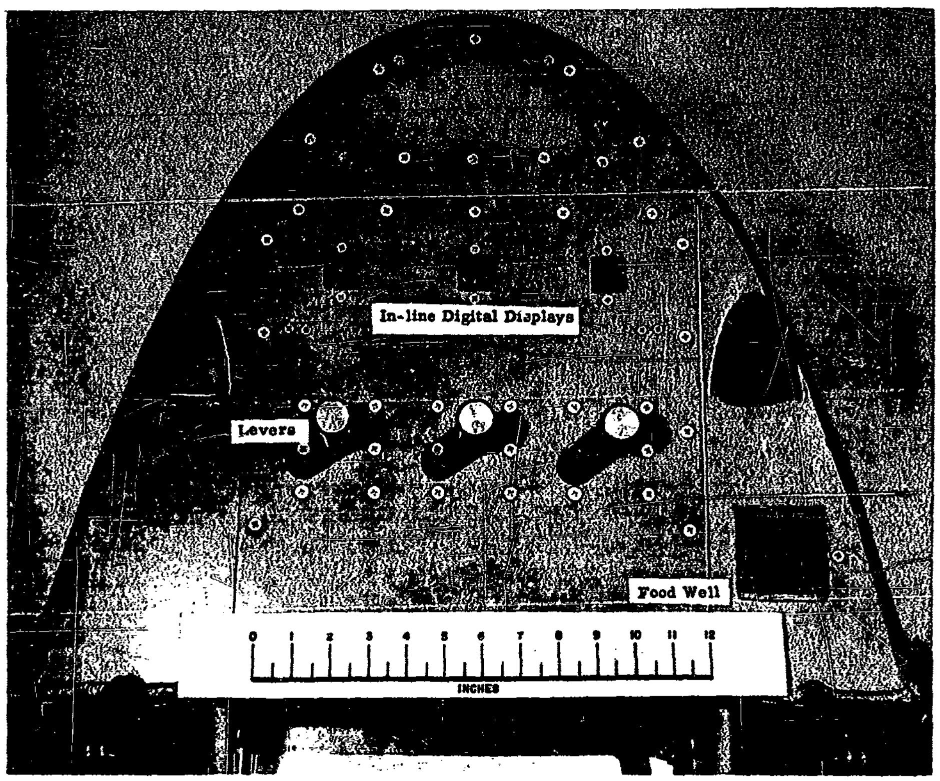

Figure 2. Performance Test Panel

The panel consisted of a row of three miniaturized In-line Digital Displays (IDD)* which were centered on a line 11.5 inches above the bottom of the panel; the center display was mounted on the mid-point of this line and the two additional IDD's were mounted on center lines which were 3.75 inches to the left and right of this point. Centered upon and mounted 4.5 inches below each display was a 1-inch diameter aluminum lever. Each lever protruded 2.5 inches beyond the face of the panel; a force of approximately 471 grams was required to activate each lever. A well for receiving food pellets was located in the lower right hand side of the panel. These were delivered into the well by means of a Foringer 1184 pellet feeder** which was mounted above and to the rear of the panel (see Fig. 1). Each food pellet*** weighed one gram, contained 3.315 Calories, and was designed specifically for use in this feeder. The nutritional analysis for these pellets is presented in Appendix B.

Mounted on the right side of the couch and level with the subject's mouth was a lip-lever drinking tube. Described in detail elsewhere (Ref. 1), it consisted of a light to signal the

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* The In-line Digital Displays are manufactured by Industrial Electronic Engineers, Inc., 5528 Vineland Avenue, North Hollywood, California; the stock number of the miniaturized unit is 140 D 76-V, price $35,00.

** The pellet feeder is manufactured by Foringer and Company, Rockville, Maryland.

*** The food pellet is the product of Ciba Pharmaceutical Products Inc., 556 Morres Ave., Summitt, New Jersey.

subject that water was available and a drinking-tube switch arrangement which, when bitten by the subject, delivered a controlled amount of water.

C. Performance Task

Prior to beginning this study, the subject was trained on a five component modified operant conditioning schedule (Ref. 2); the details of the training procedures are reported elsewhere (Ref. 3). The first two components, continuous avoidance (CA) and discrete avoidance (DA) were performed simultaneously. The stimulus for the continuous avoidance program was a red light presentation on the right IDD. During this program, the subject had to press the right lever at least once every 20 seconds in order to avoid electric shock (400 volt AC, 5ma.). Thus, each press of the right lever delayed the delivery of the shock for 20 seconds. In addition, a white light flashed on the middle IDD with each response of the right lever. At the same time as the subject was performing on the CA program, a blue light was activated on the left IDD to cue the subject for the discrete avoidance task. This light came on once every two minutes, or seven times during the period that the CA program was in effect. When the blue light came on, the subject had to press the left lever within five seconds in order to avoid electrical shock. If this response was made within five seconds after the appearance of the blue light, the light was turned off and no shock was administered. Performance on the CA program was measured in terms of the number of lever presses per minute; the DA component was essentially a visual monitoring task and was measured in terms of reaction time.

The third component required the subject to perform on a differential reinforcement of low rate (DRL) operant conditioning program. The stimulus which cued the subject to perform on this schedule was the illumination of a green light on the right IDD. When this program was in effect, the subject had to space his responses on the right lever 20 seconds apart. For example, if the subject pressed the lever at time zero, and waited to press it the second time at time 20 seconds or longer, the light would come on at the lip-lever drinking tube to signal that water was available; if, however, the subject made his second lever press after only 19 seconds, he would have to wait until time zero plus 39 seconds to make his third lever press in order to receive reward, or 20 seconds since the previous lever press. Performance on the DRL program was measured by the ratio of number of rewards to the number of times that water was potentially available to the subject. For example, during the 15 minute DRL (20 sec.) period, water is potentially available 45 times (3 20-sec. periods per minute for 15 min.). If the subject received 45 reinforcements during this period, he would be receiving 100 percent of the available reinforcements.

The fourth component was a fixed ratio (FR) reinforcement program for food reward. The stimulus for this program was the illumination of a yellow light on the middle IDD. When this light was on, the subject had to press the middle lever 50 times for one pellet of food. Performance on this schedule was measured by computing the number of lever presses per minute.

The fifth component of the task consisted of the 18 oddity problems shown in Table I (Ref. 4).

TABLE I

Eighteen Problems of the
Oddity Component in
Order of Presentation

Problem	Symbol on Display		
	Left	Middle	Right
1	○	△	○
2	△	△	○
3	○	○	□
4	△	○	○
5	△	○	△
6	□	□	△
7	○	□	□
8	△	□	□
9	△	△	□
10	□	○	□
11	□	△	△
12	○	□	○
13	○	○	△
14	○	△	△
15	△	□	△
16	□	○	○
17	□	△	□
18	□	□	○

One problem at a time was presented to the subject by means of the three IDDs and each problem had two symbols which were alike and one which was different. When the symbols were presented, the subject had five seconds in which to press the lever under the symbol which was different from the other two.

If a correct discrimination was made within this time, all displays were turned off for 15 seconds; if the subject failed to respond within five seconds or made an incorrect discrimination, he received an electric shock and then all displays were turned off for 15 seconds, after which the same problem was presented again. Performance on this task was measured in terms of discrimination accuracy by the following formula:

$$\text{Decision Making Efficiency} = \frac{18}{\text{Decision Making Events}}$$

All components of the performance schedule were programmed by standard commercial operant conditioning equipment. Each component was separated by a two minute rest period, and the complete performance schedule with rest periods required 66 minutes. The time that each component was in effect is shown in Table II.

TABLE II

Time Schedule for Each Component of the Performance Task

Time (min)	Component
0-15	CA-DA
16-17	Rest
18-32	DRL - 20
33-34	Rest
35-49	FR - 50
50-51	Rest
52-66	Oddity

D. Procedure

As mentioned previously, the subject had been trained on all components of the performance schedule and had performed in the couch with the test panel used in this study. Two days prior to the start of this investigation, the subject was given a complete physical examination. Blood and urine analyses were made, chest X-rays were taken, and the general physical condition of the subject was assessed.

On the day the study began a copper sulphate respiration sensor was placed around the subject at the area of the eleventh intercostal space; a thermistor was taped to the medial aspect of the right thigh and three electrocardiogram leads were sutured to the subject with stainless steel wire; two of these leads were placed over the right and left lateral thorax, respectively, and the third was placed on the medial aspect of the left thigh. On the twelfth day of the study it was discovered that the subject had pulled the thermistor off of his thigh so the cubicle was opened and the thermistor which had been attached to the subject's thigh was attached to the medial aspect of his right calf. The location of these sensors is shown in Figure 3. The physiological measures of pulse and respiration were recorded on a Sanborn recorder; skin temperature was recorded by means of a Yellow Springs Instrument Co., Tele-Thermometer. Following the attachment of these sensors, a nylon suit was placed on the subject, and the subject was loosely restrained in the couch by the straps that fit through the slots in the couch. Leather shoes for delivering shock were placed on the subject and his legs were restrained with nylon lacing.

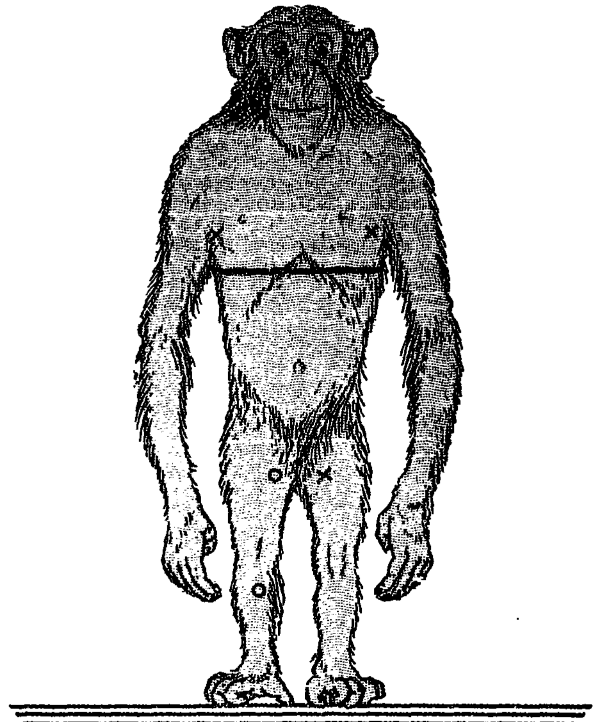

Figure 3. Location of the Physiological Sensors (X indicate electrocardiogram leads; line across chest represents respiration sensor; O shows the location of the thermistor at both the calf and groin.)

Forty minutes before the test began, the doors of the cubicle were closed and a check of the physiological recording was conducted. At time zero, the performance test was turned on, however, this was preceded by a 1024 cps 60 db tone which was turned on for approximately 20 seconds to alert the subject; this procedure was repeated at the beginning of each work session. Since this was to be a model for an orbital flight, an orbit of 90 minutes duration was assumed, which meant that there would be 16 orbits per 24-hour period. The performance schedule for each of the orbits is presented in Table III and provided for 8 hours 42 minutes of work and 15 hours 18 minutes of rest during each 24-hour period.

TABLE III

Daily Performance Schedules By Orbits

Orbit	Performance	Time (Min) Work	Time (Min) Rest
1	All components	66	24
2	All components	66	24
3, 4, 5	None	0	270
6	All components	66	24
7	CA-DA only	15	75
8	All components	66	24
9	CA-DA only	15	75
10	All components	66	24
11, 12	None	0	180
13	CA-DA only	15	75
14	CA-DA only	15	75
15	All components	66	24
16	All components	66	24
		522	918
		8 hr. 42 min.	15 hr. 18 min.

Pulse and respiration rates were determined for one minute every 15 minutes throughout the 14-day period and skin temperature was recorded at the end of each 15-minute period. Every 30 minutes the temperature inside the cubicle was recorded. Beginning 24 hours after the initiation of the test, the urine volume and feces weight were determined for each 4-hour period. Pellet and water consumption were measured every 8 hours.

On four separate occasions, the cubicle was opened to remedy certain malfunctions. Three hours and 30 minutes after the test began, the feeder had to be repaired, and 9 hours after the test started a burned out lamp was replaced in one of the IDDs. On the tenth hour of the twelfth day, it was discovered that the skin temperature was not obtainable because the subject had pulled off the skin temperature sensor. A new sensor was placed on the subject's calf at this time, resulting in a lower reading of this measurement. On another occasion it was found that the wire on the programming equipment responsible for turning on the blue light for the DA schedule had become disconnected; this resulted in the subject receiving 4 shocks, however, subsequent performance was unimpaired.

For the first five days of the test the subject was rewarded on the DRL performance component with distilled water. On the seventh day, the distilled water in the reservoir was emptied and replaced with a solution consisting of nine parts of distilled water and one part of lactated Ringer's solution. This mixture was used to reward DRL performance on days 6, 8, 10, 12, and 14; on days 1 through 5 and 7, 9, 11, and 13 distilled water was used. On the fourteenth hour of the fifteenth day, the subject was removed from the cubicle and a post-test physical examination was administered.

III. RESULTS

The ranges, means, standard deviations, and standard errors of the means of the physiological measures were computed and are presented together with the information on cubicle temperatures in Table IV.

TABLE IV

Rang. s, Means, Standard Deviations, and Standard Errors of the Means of the Cubicle Temperature, and Physiological Measures

MEASURE	OBSERVATIONS	RANGE	MEAN	S.D.	$S.E._m$	$S.E._m$ (05)	$S.E._m$ (.01)
CUBICLE TEMP. °F	696	75.0-85.0	80.1	1.94	.07	0.14	0.19
PULSE/Min.	1358	78-159	114.7	14.60	.39	0.76	1.01
RESPIRATION Min.	1369	3-60	16.5	5.10	.14	0.27	0.36
SKIN TEMP. (Groin) °F	699	93.2-98.5	95.4	39.10	1.47	2.88	3.79
SKIN TEMP. (Calf) °F	580	85.5-93.2	89.2	24.50	1.01	1.98	2.61

The amount of food and water consumed daily and the daily amount of urine and feces excreted were determined and are presented in Table V. Mean daily performance on the continuous avoidance task, discrete avoidance task, DRL program, fixed ratio task and oddity problem were computed and are presented graphically in Figures 4-8 respectively. Performance on each test session and the daily mean values for each of the tasks are presented in Appendix A.

Five 1 cc samples of feces were weighed and the mean value or specific gravity was computed to be 1.426 gms. The results of the hematological tests, blood chemistry value, urinalyses, and fecal analysis prior to the test, immediately following the test, and seven days post-test are presented in Appendix B. A clinical evaluation of these findings is the subject of another report.

IV. DISCUSSION

Of the many factors which may affect both the behavior and physiology of a living organism during space flight, two of the most critical are restraint and social isolation. Certainly this is true when the organism is an active and gregarious chimpanzee. In fact, there was considerable doubt concerning the ability to restrain a chimpanzee for fourteen days. But the results of this investigation prove conclusively that this is possible and that the recovery from prolonged restraint is rapid.

TABLE V

Daily Food and Water Consumption
and Waste Production

DAY	CONSUMPTION		WASTE PRODUCTS	
	FOOD PELLETS gm's	WATER cc's	URINE cc's	FECES gm's
1	196	50.50	—	—
2	186	475.20	232.0	69.5
3	233	1086.30	336.0	0.5
4	280	952.20	395.0	94.3
5	291	1128.9	692.0	82.0
6	244	744.70	893.0	89.6
7	283	434.60	363.0	89.5
8	256	1063.00	439.0	83.4
9	329	1123.60	643.0	123.2
10	254	773.80	531.0	72.0
11	317	1160.70	572.0	67.7
12	308	1166.00	891.0	93.4
13	350	1038.80	757.0	97.8
14	257	974.00	1086.0	83.9
$\bar{X}$	270.28	869.45	602.31	80.52
S.D.	45.8	324.64	242.70	26.8
SE_m	12.25	90.027	66.49	7.34
SE_m .05	24.01	232.27	130.32	14.39
SE_m .01	31.60	176.45	171.54	18.94

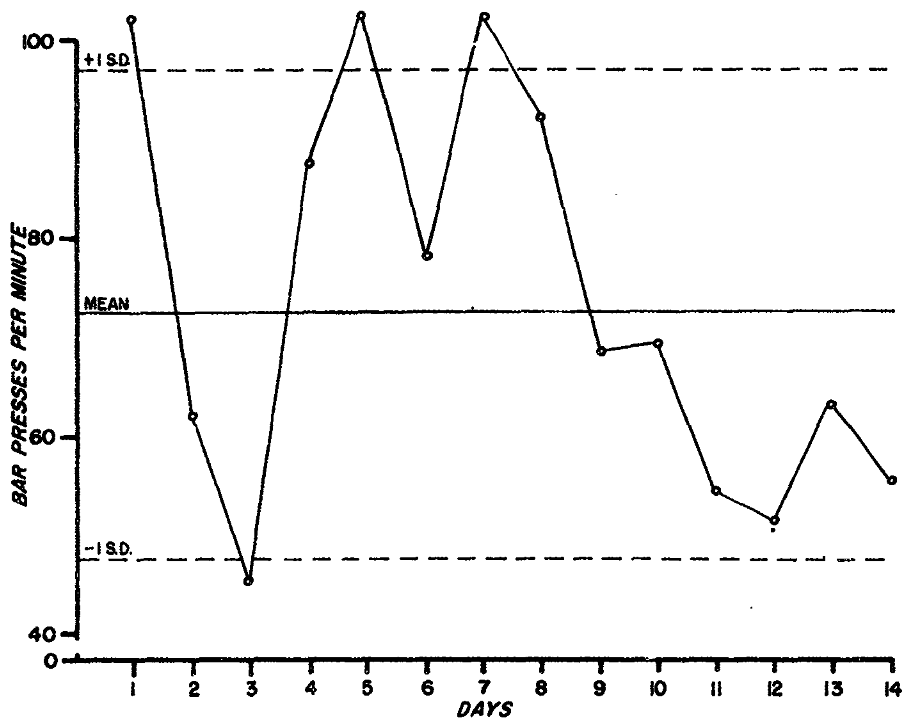

Figure 4. Daily Mean Performance on the Continuous Avoidance Task

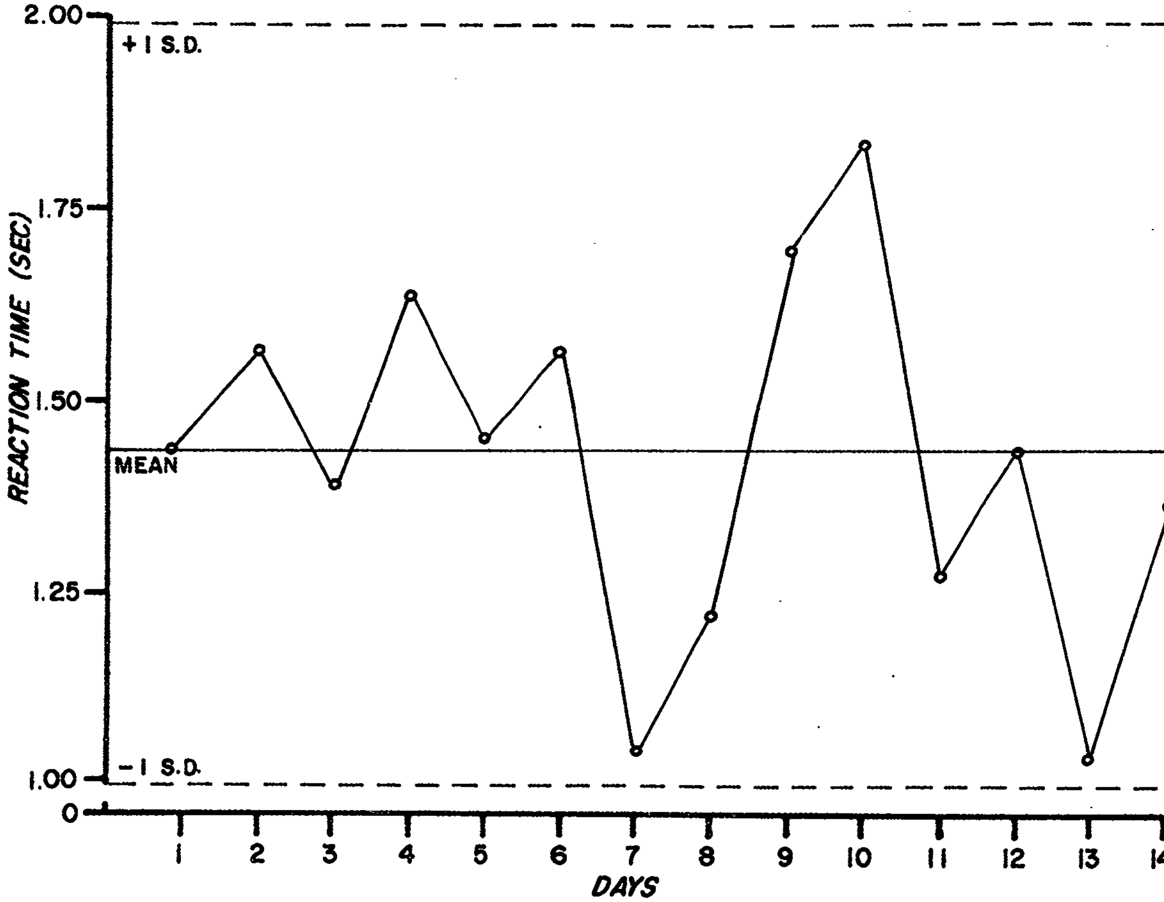

Figure 5. Daily Mean Performance on the Discrete Avoidance Task

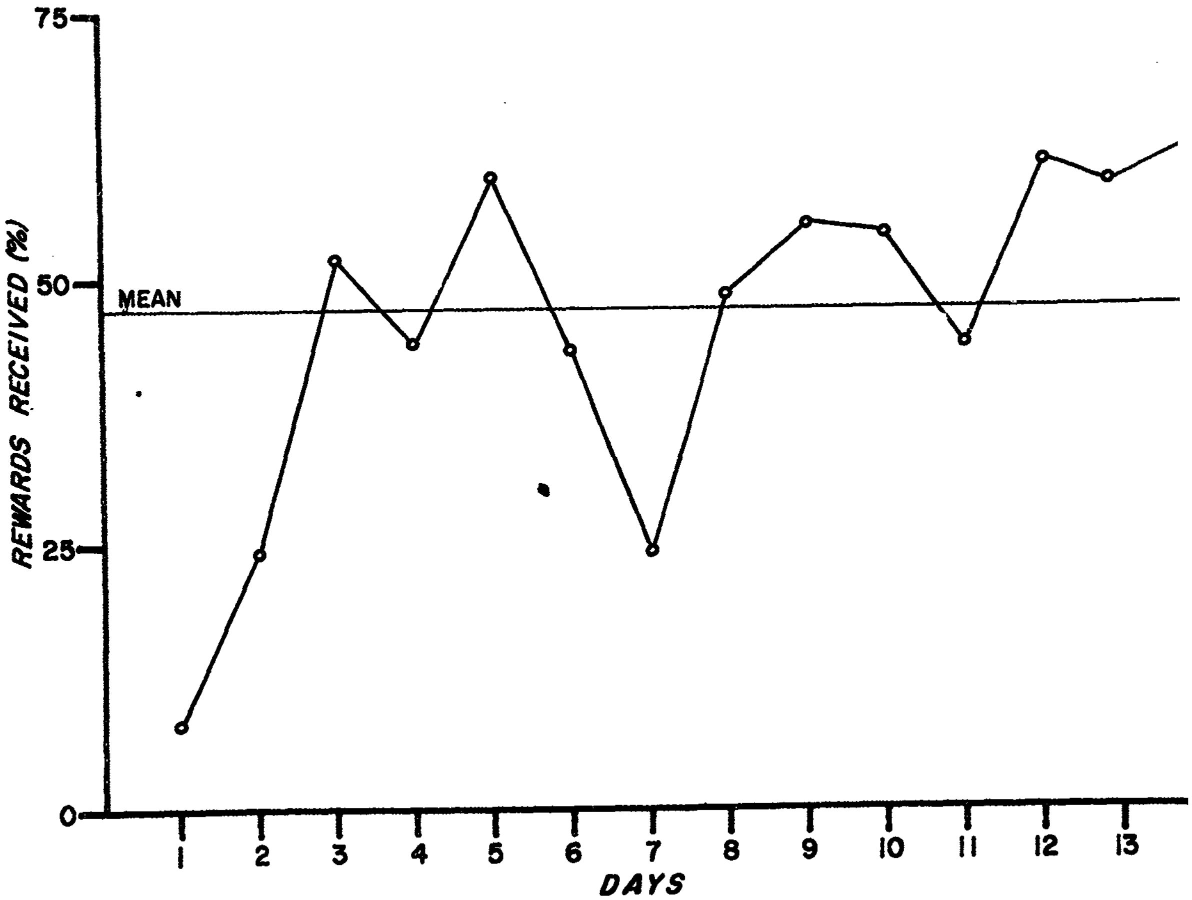

Figure 6. Daily Mean Performance on the DRL Task

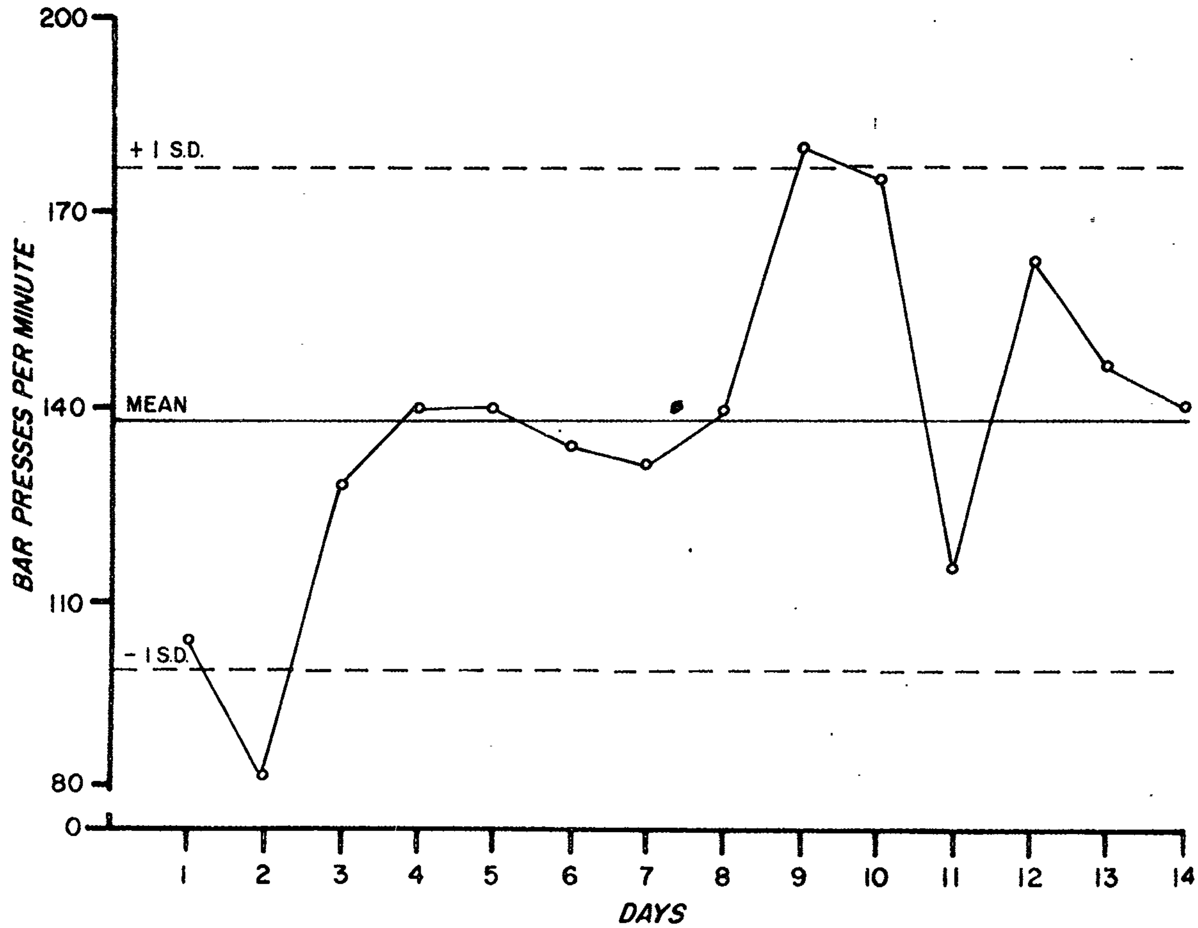

Figure 7. Daily Mean Performance on the Fixed Ratio Task

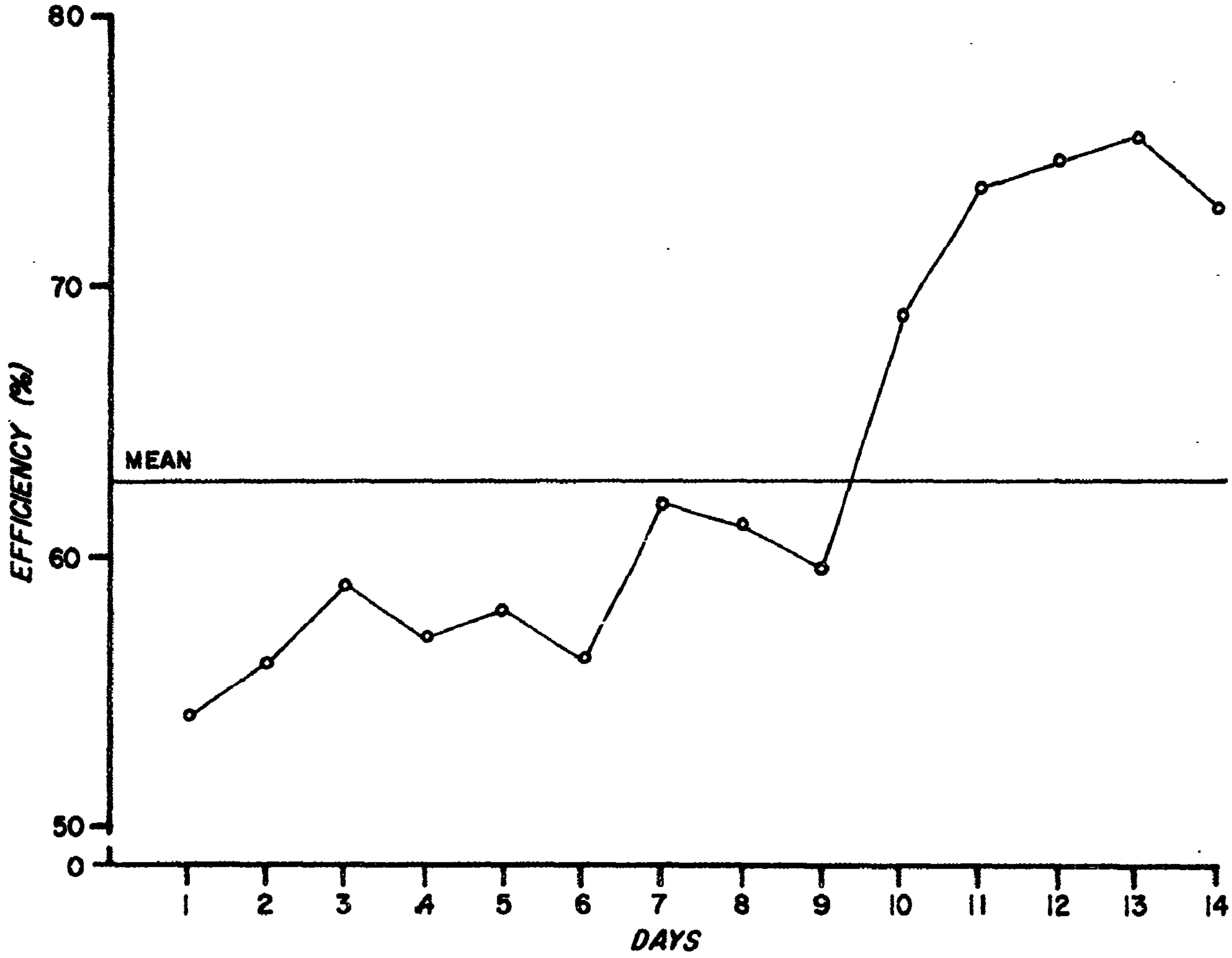

Figure 8. Daily Mean Performance on the Oddity Problem

However, aside from the foregoing conclusion, several other points are worthy of mention as they affect space flight. The first of these pertains to the four equipment malfunctions, namely, the burning out of the light bulb in the IDD unit, the malfunctioning of the feeder, the incident in which the subject loosened the thermistor from his groin, and the occasion when the blue light failed to come on. In each of these instances the cubicle was opened and the difficulty was remedied. Needless to say, this would have been impossible during actual flight. Moreover, due to the feeder defect, the subject would not have received food for 13 days and possibly would have starved to death or certainly been in serious physical condition. These facts clearly point to the need for having duplicate and independent electrical and mechanical components in the spacecraft. Had there been two feeders, each independently wired and programmed, two light bulbs, and several thermistors for measuring skin temperature, the probability of malfunction would have been greatly reduced.

A second important finding, from an engineering standpoint, was the determination of the amount of food and water required to sustain the subject for the 14-day period. Equally important was the measurement of the waste products. In this regard, it should be pointed out that the system employed for collecting the waste was extremely efficient. When the subject was removed from the couch, the back of the nylon restraint suit was urine-stained, however, there was no accumulation of either urine or feces in the couch. This fact is demonstrated in Appendix C, in the photograph of the couch which was made immediately after the subject was removed.

In terms of physiological baselines, the results of this investigation clearly define the parameters of skin temperature, respiration, and pulse for the young chimpanzee under the experimental conditions of this study.

The results of the performance also present interesting findings. Most striking is the performance of the oddity problem which shows that the subject improved or learned during the course of the study; an improvement in performance on the DRL task was also observed. The performance on the CA, DA, and FR components were within range of the pretest mean plus or minus one standard deviation. However, the most critical factor of the performance aspect of the study was that the subject worked for all his food and water. No ad libitum food nor water was given to the subject, yet the subject weighed the same at the end of the experiment as at the beginning. This fact shows the scheduling of the work-rest periods and, in particular, the FR and DRL components to be adequate for sustaining an animal for the period of this study.

When the subject was removed from the couch he was extremely weak and had difficulty placing weight on his right leg. However, this is understandable when considering the position of the legs during the 14-day period. One factor that should be mentioned in this regard is that the subject's legs were laced to the couch quite tightly and the leather shoes were also securely laced. All other restraint was loose. Nevertheless, 24 hours after the subject was removed from the couch, he was putting his full weight on this leg. His recovery was rapid and with the exception of a small sore at the base of his spine where he apparently rubbed against the couch, no serious physical effects were noted.

V. SUMMARY AND CONCLUSIONS

A young chimpanzee was restrained and isolated from the usual laboratory distractions for 14 days. For approximately nine hours each day he performed a complex performance schedule; on two programs of this schedule he was rewarded with food and water. Skin temperature, pulse and respiration were monitored and feces and urine output were measured. On the basis of the results of this study, it was concluded that the chimpanzee could withstand social isolation and restraint for 14 days without serious physical damage or behavior impairment. The number of equipment malfunctions, while few, point to the need for redundancy in all electrical and mechanical systems. The results also establish standards for food and water consumption, waste production, skin temperature, pulse, and respiration. The performance schedule provided the subject with sufficient food and water since the animal did not lose any weight for the 14-day period. Improvement in the performance of the behavioral tasks occurred during the study. And while the subject was weak when removed from the couch, his recovery was rapid.

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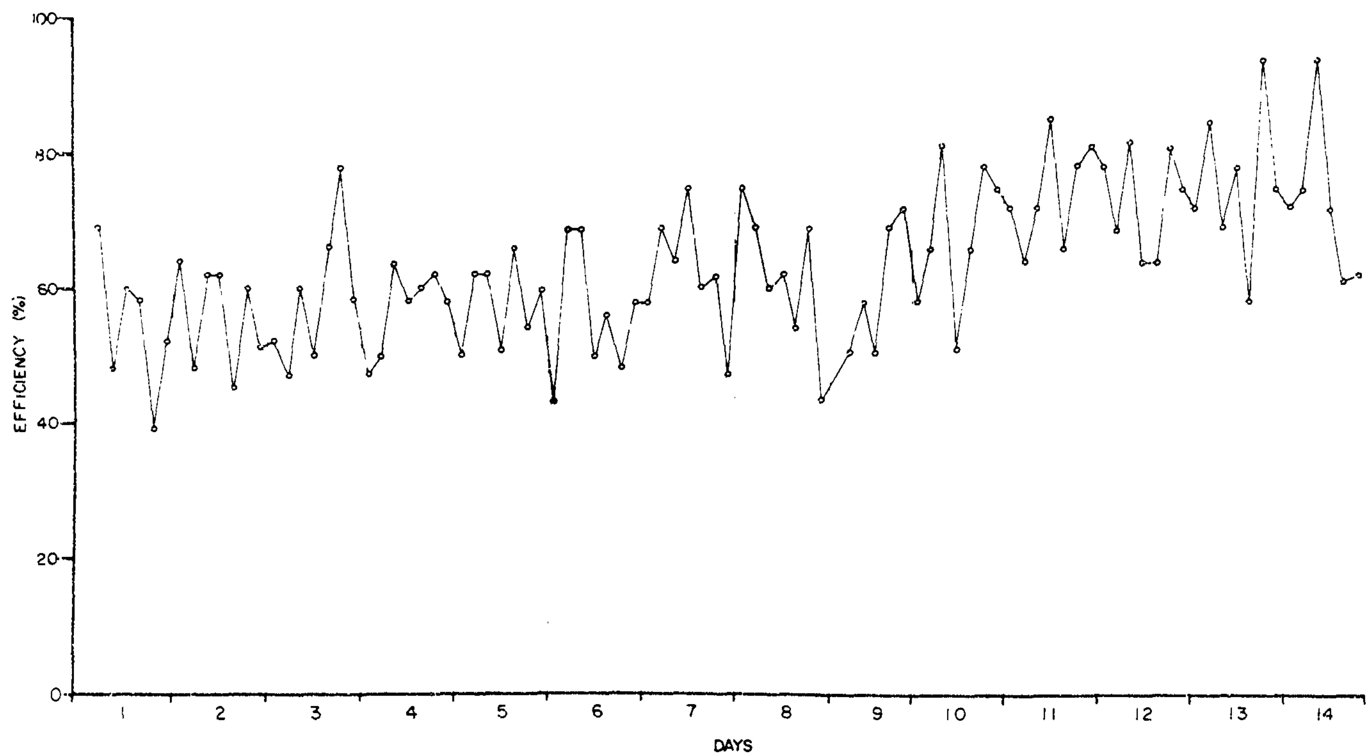
APPENDIX A

PERFORMANCE DATA

Daily Summary Statistics
Individual Performance Sessions

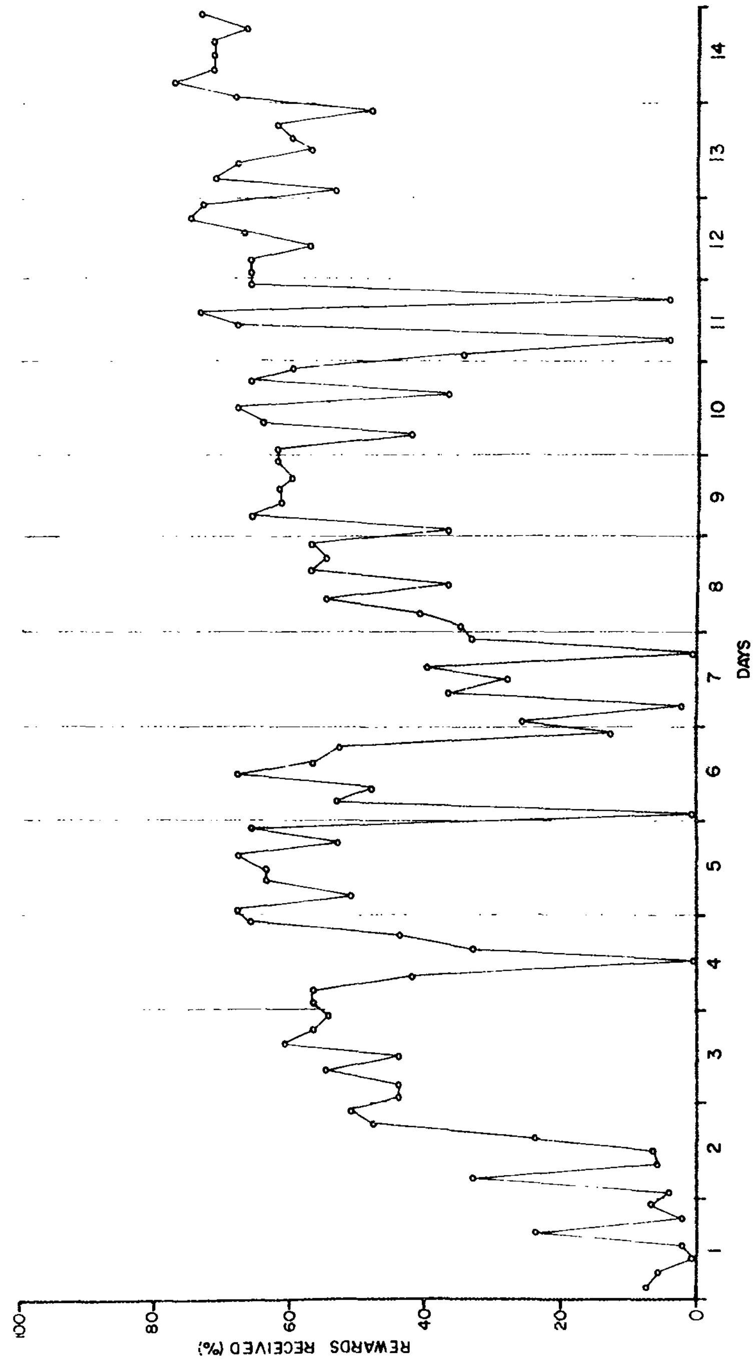
SUMMARY STATISTICS BY DAY OF PERFORMANCE ON THE ODDITY PROBLEM		
DAY	NUMBER OF 18 PROBLEM SESSIONS	PERCENTAGE OF CORRECT DECISIONS TO TOTAL DECISION MAKING EVENTS
1	6	54.50
2	7	56.26
3	7	59.03
4	7	57.12
5	7	58.09
6	7	56.47
7	7	62.27
8	7	61.99
9	6	58.93
10	7	68.27
11	7	74.39
12	7	75.69
13	7	76.17
14	7	73.08
ALL DAYS	96	63.73

PERFORMANCE ON THE ODDITY PROBLEM
(BY INDIVIDUAL SESSION)



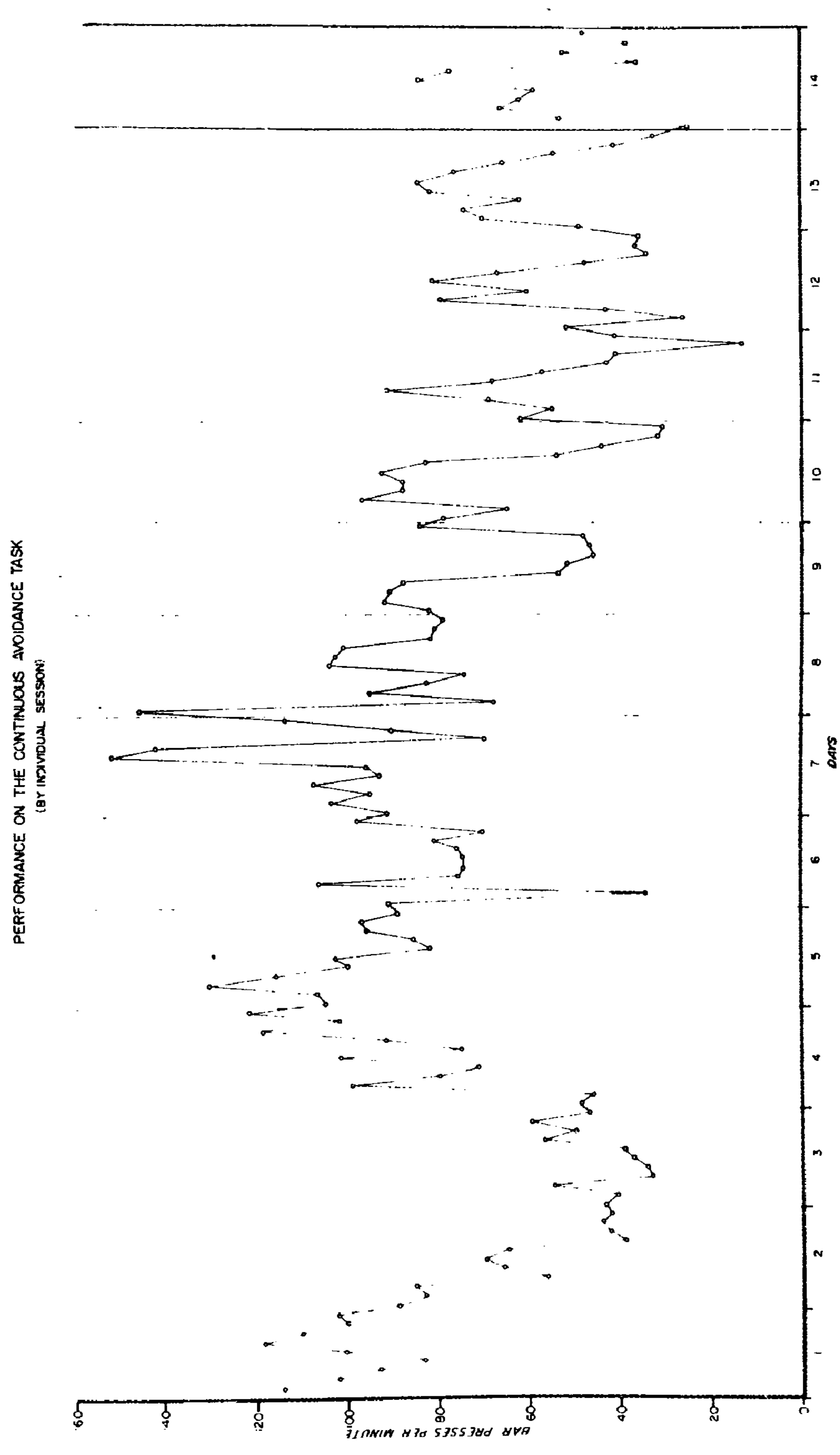
SUMMARY STATISTICS BY DAY OF PERFORMANCE ON D.R.L. TASK		
DAY	NUMBER OF 15 MINUTE SESSIONS	PERCENTAGE OF REWARDS RECEIVED TO NUMBER OF POSSIBLE REWARDS
1	6	7.40
2	7	24.12
3	7	52.06
4	7	43.17
5	7	62.54
6	7	42.22
7	7	24.12
8	7	48.88
9	6	58.52
10	7	57.46
11	6	42.22
12	6	65.18
13	7	60.31
14	7	71.25
ALL DAYS	94	47.10

PERFORMANCE ON THE D.R.L. TASK
(BY INDIVIDUAL SESSION)



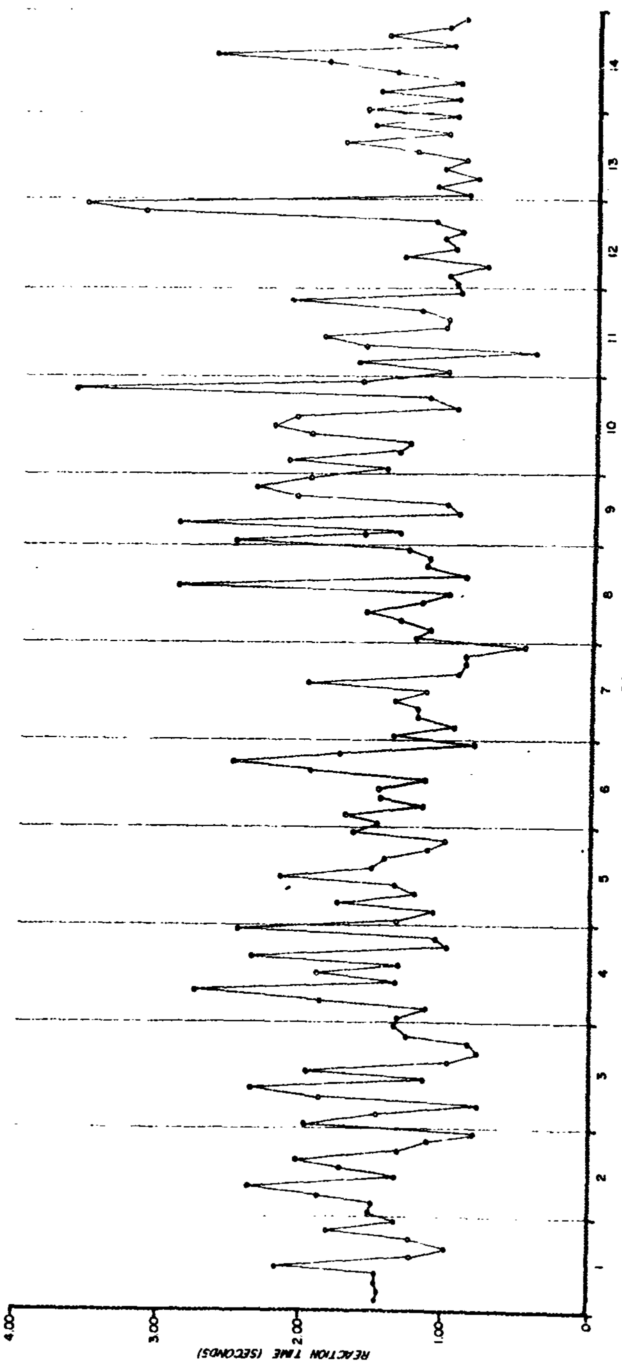
DAY	NUMBER OF 15-MINUTE CA SESSIONS	RATE IN BAR PRESSES PER MINUTE					
		RANGE	MEAN	S. D.	S.E.$_m$	S.E.$_m$ (.05)	S.E.$_m$ (.01)
1	8	83.0-118.1	102.64	25.75	2.35	4.61	6.06
2	11	39.5-89.3	62.37	16.22	1.26	2.47	3.25
3	11	33.2-60.5	45.48	11.58	0.90	1.76	2.32
4	11	46.1-122.3	87.46	22.69	1.77	3.47	4.57
5	11	82.7-131.2	102.51	25.81	2.01	3.94	5.18
6	10	33.3-107.4	78.62	20.20	1.65	3.23	4.26
7	11	73.7-142.3	102.09	26.29	2.05	4.02	5.29
8	11	68.9-146.1	92.97	21.12	1.64	3.21	4.23
9	10	46.3-92.2	68.73	17.85	1.46	2.86	3.77
10	11	31.3-97.7	69.16	18.28	1.42	2.78	3.66
11	10	11.5-91.6	54.26	14.53	1.19	2.33	3.07
12	11	26.8-81.2	51.72	13.67	1.06	2.08	2.73
13	11	33.4-84.9	63.01	16.24	1.26	2.47	3.25
14	11	25.2-84.9	55.04	14.45	1.12	2.19	2.89
ALL DAYS	148	25.2-146.1	73.56	24.43	2.01	3.93	5.18

SUMMARY STATISTICS BY DAY OF PERFORMANCE ON THE CONTINUOUS AVOIDANCE TASK


PERFORMANCE ON THE CONTINUOUS AVOIDANCE TASK
(BY INDIVIDUAL SESSION)
BAR PRESSES PER MINUTE
DAYS
0
20
40
60
80
100
120
140
160
1
2
3
4
5
6
7
8
9
10
11
12
13
14

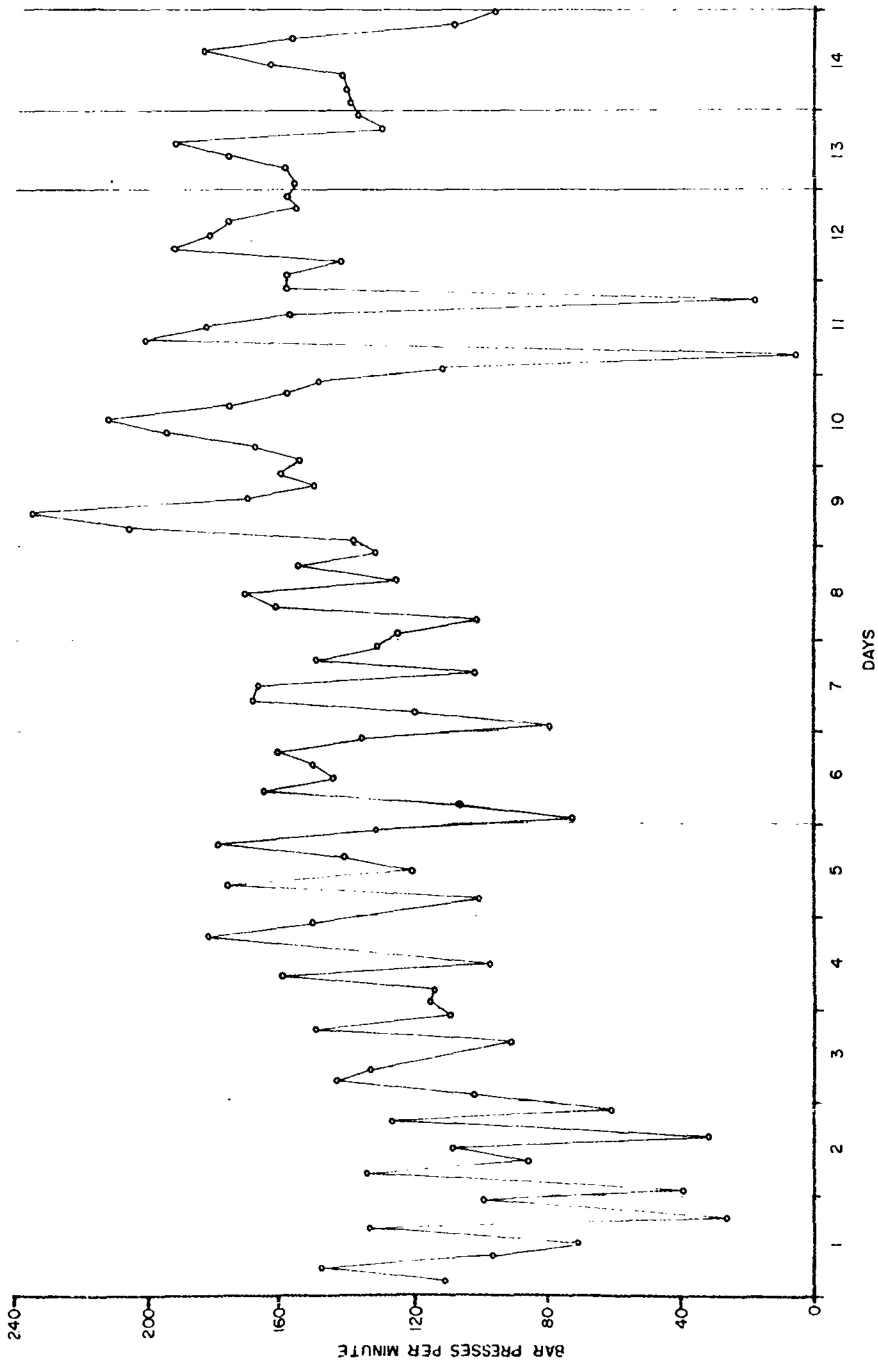
SUMMARY STATISTICS BY DAY OF PERFORMANCE ON THE DISCRETE AVOIDANCE TASK							
DAY	BLUE LIGHT PRESENTATIONS	REACTION TIME (SEC.)					
		RANGE	MEAN	S.D.	$SE._m$	$SE_m(.05)$	$SE_m(.01)$
1	62	0.92-2.17	1.45	.264	.033	.065	.085
2	66	0.78-2.36	1.55	.601	.075	.147	.194
3	74	0.75-2.30	1.39	.524	.060	.118	.155
4	76	0.99-2.74	1.68	.632	.072	.142	.187
5	76	1.00-2.18	1.42	.502	.057	.112	.148
6	61	0.88-2.50	1.55	.599	.076	.148	.195
7	69	0.48-1.99	1.12	.436	.053	.104	.137
8	76	0.88-2.87	1.23	.490	.056	.110	.145
9	64	0.95-2.49	1.78	.671	.084	.164	.216
10	66	0.95-3.64	1.81	.738	.091	.178	.235
11	59	0.48-2.17	1.29	.524	.068	.133	.175
12	66	0.67-3.57	1.41	.651	.082	.159	.210
13	63	0.77-1.76	1.12	.407	.049	.095	.125
14	71	0.91-1.81	1.38	.539	.064	.125	.165
ALL DAYS	949	0.48-3.64	1.45	.569	.018	.036	.048

PERFORMANCE ON THE DISCRETE AVOIDANCE TASK
(BY INDIVIDUAL SESSION)



SUMMARY STATISTICS BY DAY OF PERFORMANCE ON THE FIXED RATIO TASK							
DAY	NUMBER OF 15 - MINUTE FR SESSIONS	RATE IN BAR PRESSES PER MINUTE					
		RANGE	MEAN	S. D.	$S.E._m$	$S.E._m$ (05)	$S.E._m$ (01)
1	7	25.0-148.8	98.70	24.88	2.43	4.76	6.27
2	7	31.7-135.8	82.76	22.82	2.23	4.37	5.75
3	7	90.0-150.0	125.71	31.88	3.11	6.09	8.02
4	7	95.3-181.1	140.76	39.73	3.88	7.60	10.01
5	7	100.0-179.9	140.81	37.99	3.70	7.25	9.55
6	7	73.9-165.5	134.09	34.34	3.35	6.57	8.64
7	7	79.5-168.0	131.25	31.15	3.04	5.96	7.84
8	7	103.6-171.5	139.47	35.27	3.44	6.74	8.88
9	6	138.1-236.3	177.74	45.19	4.76	9.33	12.28
10	7	149.7-211.4	173.62	43.64	4.26	8.35	10.99
11	7	6.8-200.0	119.91	35.24	3.44	6.74	8.88
12	7	132.1-191.5	165.14	41.46	4.04	7.92	10.42
13	7	129.3-191.1	155.71	39.19	3.82	7.49	9.86
14	7	95.7-175.0	140.97	35.82	3.49	6.84	9.00
ALL DAYS	97	6.7-236.3	139.08	36.56	3.71	7.27	9.57

PERFORMANCE ON THE FIXED RATIO TASK
(BY INDIVIDUAL SESSIONS)



APPENDIX B

Physical Examinations

Nutritional Analysis of Food Pellets

Food Pellet Composition

Physical Examinations

I. HEMATOLOGY:

	Pre-Test	Immediate Post-Test	7 Days Post-Test
White Blood Count	8,100	20,100	21,350
Differential:	200 cells counted	200 cells counted	200 cells counted
Neutrophiles	44	75	140
Blasts	0	0	2
Myelocytes	0	0	8
Bands	3	1	7
Lymphocytes	136	109	43
Monocytes	0	11	0
Eosinophiles	17	4	0
Basophiles	0	0	0
Platelets	174,000	182,500	290,000
Sedimentation Rate	18 mm	8 mm	21 mm
Red Blood Count	5.19 - 5.34	4.84	6.21
Hematocrit	45%	46%	49%
Hemoglobin	14.06 gms	15.17 gms	not recorded

II. BLOOD CHEMISTRY VALUES:

	Pre-Test	Immediate Post-Test	7 Days Post-Test
Urea Nitrogen	7.4 mg%	9.3 mg%	8.5 mg%
Total Protein	7.65 gm%	7.8 gm%	8.1 gm%
Chloride	98.2 mEq/L	95.0 mEq/L	94.5 mEq/L
Calcium	9.65 mg%	9.8 mg%	10.6 mg%
Creatinine	1.3 mg%	1.8 mg%	1.44 mg%
Sodium	139.6 mEq/L	147 mEq/L	140 mEq/L
Potassium	3.6 mEq/L	3.8 mEq/L	5.1 mEq/L
CO_2	71.8 Vol %	81.4 Vol %	Not reported

III. URINALYSES:

	Pre-Test	Immediate Post-Test	7 Days Post-Test
Reaction	7.0	7.0	
Specific Gravity	1.003	1.015	
Albumin	Neg	Neg	
Sugar	Neg	Neg	
Microscopic	occasional renal epithelial cells and rare WBC's	few trichomonas 0-1 RBC's/HPF 1-2 WBC's/HPF	

IV. FECAL ANALYSES:

	Pre-Test	Post-Test
Appearance	Brown	Light Brown - Tan
Consistency	Soft Formed	Hard Formed
Blood	Negative	Negative
Pus	Negative	Numerous pus cells - microscopic
Mucous	Negative	Negative
Ova and Parasites	Occasional B Coli	Negative

Data from the physical examinations and the clinical tests supplied by the Veterinary Services Branch, Aeromedical Field Laboratory.

Nutritional Analysis of Food Pellets *

Protein	26.21 %
Fat	3.99 %
Ash	3.44 %
Carbohydrate	55.64 %
Fiber	1.40 %
Calcium (mg/100 gm)	877.70
Phosphorus (mg/100 gm)	513.00
Iron (mg/100 gm)	5.27

* Information supplied by Dr. Dominic Finocchio, Ciba Pharmaceutical Products, Inc., 556 Morres Avenue, Summitt, New Jersey.

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Food Pellet Composition *

Sucrose	14 %
Banana flake	20 %
Soybean flour	30 %
Dried egg white	10 %
Non-fat dry milk	8 %
Dried whole egg	4 %
Wheat germ	5 %
Brewers yeast	2 %
Sodium saccarin Sodium sucrose	1 %
Calcium lactate	0.70 %
Iodized salt	0.01 %
Vitamins	
A - D B_1 - B_6 Pantothenic acid Nicotine acid C	0.25 %
Binder	4 %

* Information supplied by Dr. Dominic Finocchio, Ciba Pharmaceutical Products, Inc., 556 Morres Avenue, Summitt, New Jersey.

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APPENDIX C

Miscellaneous Figures

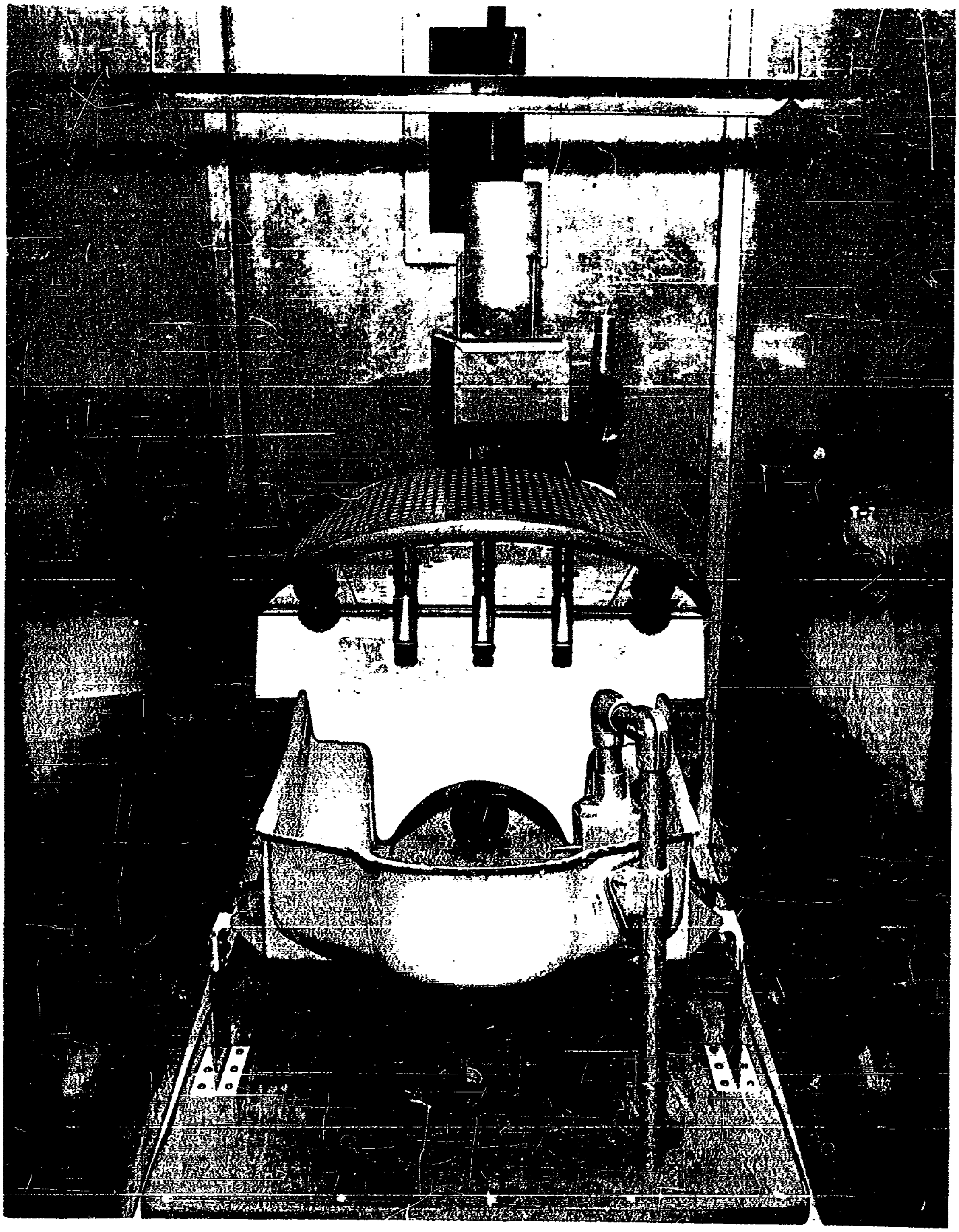

Figure 9. View of Couch and Work Panel Inside Cubicle Previous to Simulated Flight

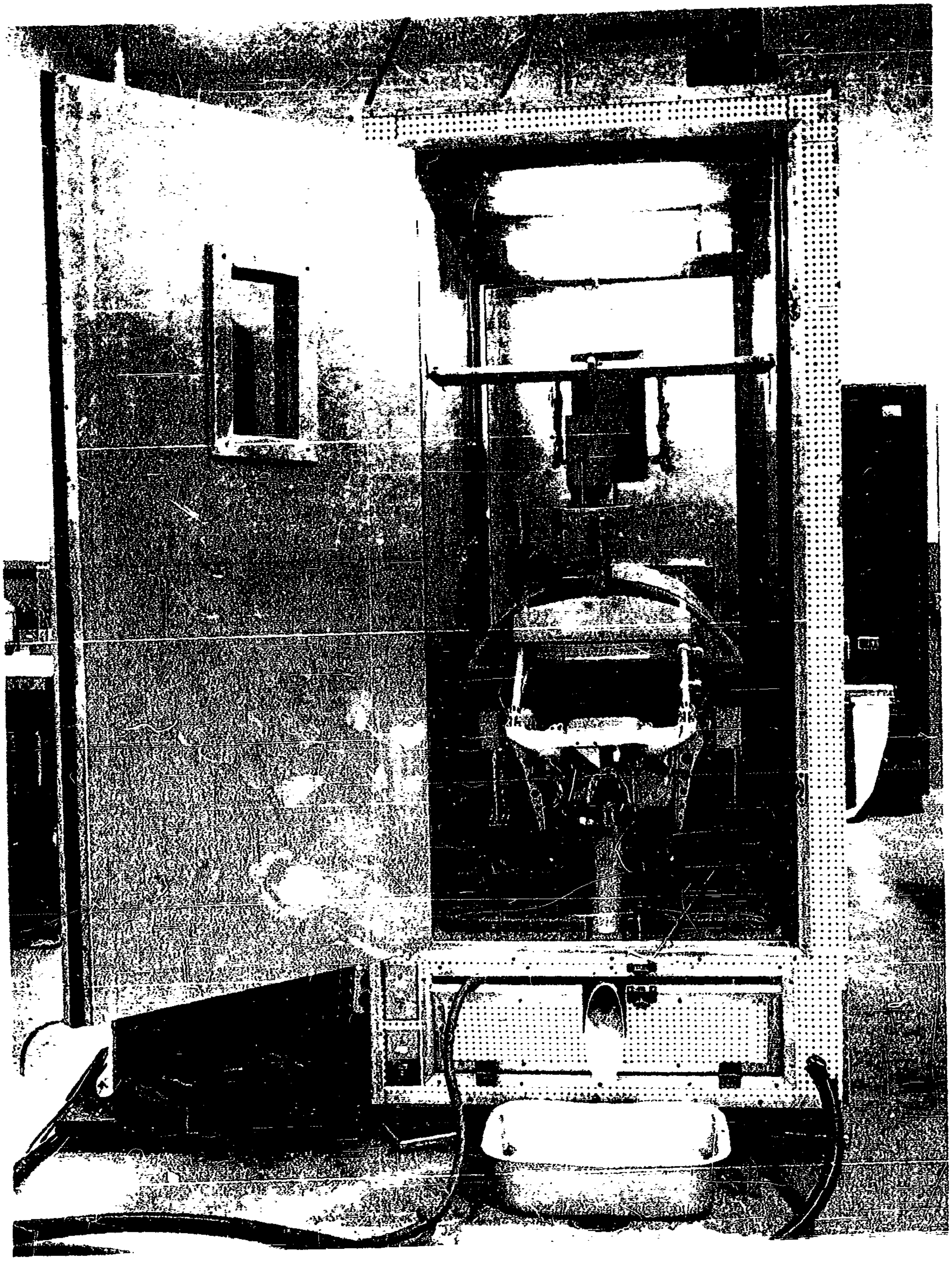

Figure 10. Foot View of Couch Inside Cubicle

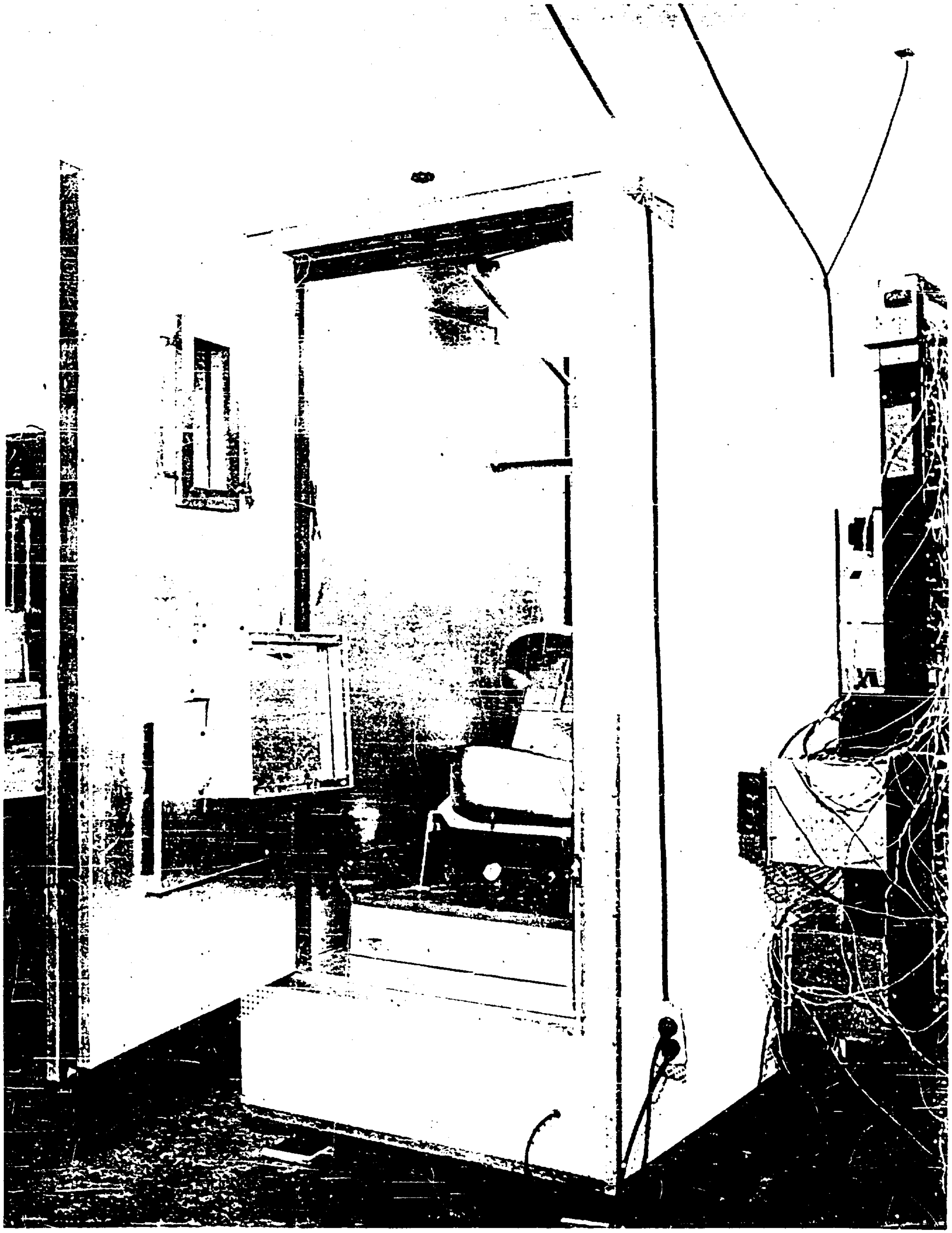

Figure 11. Head View of Couch Inside Cubicle Showing Monitoring Mirror


Figure 12. View of Chimpanzee Showing Skin Sensors Following 14-Day Simulated Flight

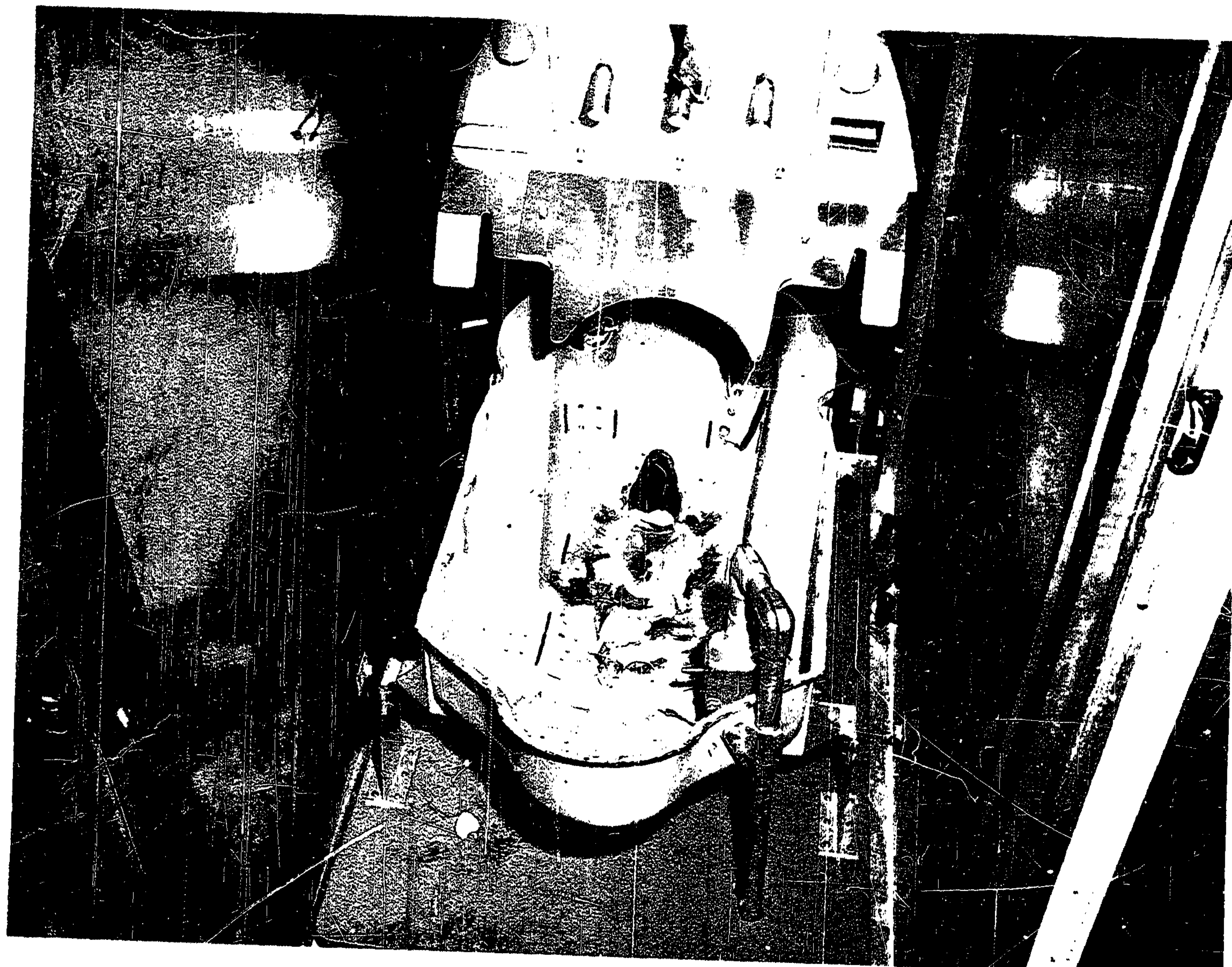

Figure 13. View of Couch and Work Panel Inside Cubicle Following 14-Day Simulated Flight

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